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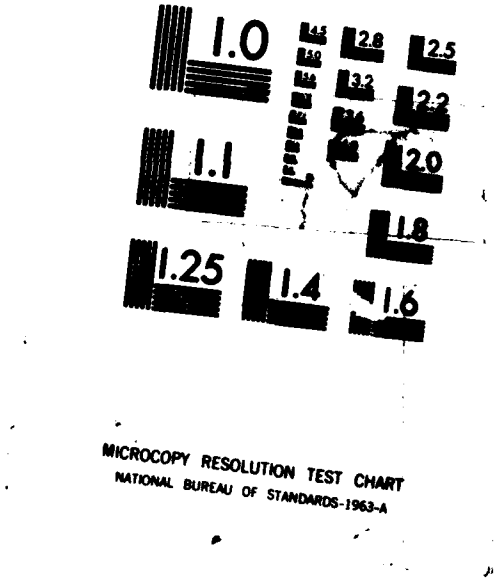

COST EFFECTIVENESS OF ARCHITECT-ENGINEER TITLE II SERVICES

THESIS

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Captain, USAF

AFIT/GEM/DEM/87S-18

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AFIT/GEM/DEM/87S-18

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THESIS

Presented to the Faculty of
the School of Systems and Logistics
of the Air Force Institute of Technology
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Master of Science in Engineering Management

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Abstract

The purpose of this study was to determine the cost effectiveness of Architect-Engineering (A-E) Title II (inspection) services. There are two related questions which directed this study: What is the most cost effective method for using Title II services? How does this compare to increasing the number of government inspectors?

The study found several items to improve the effective use of A-E Title services.

First, a well written Statement of Work will help eliminate the problems caused by coordination and communication difficulties. A Statement of Work to be used as a guide is included in Appendix E of this thesis.

Next, a linear regression model was developed to give a general idea of the appropriate ratio of inspection cost to construction cost.

Finally, a table was created to give the point at which it would be more cost effective to use an in-house inspector rather than an A-E inspector.

COST EFFECTIVENESS OF ARCHITECT-ENGINEER TITLE II SERVICES

I. Introduction

General Issues

During the period from 1974 to 1984, there has been an increase in construction projects in the Air Force, reflected in a cost of construction that, accounting for inflation, has nearly doubled (11:31). Architect-Engineering (A-E) firms have been hired to inspect the additional work the Contract Management Section has been unable to do. The question is this: how cost effective is the use of A-E's?

Specific Problems

There are two related questions that need to be answered. What is most cost effective method for using A-E Supervision and Inspection Services (Title II) that is currently available to the Air Force? How does this compare to the costs/benefits of increasing the number of government inspectors (military and civilian)?

Investigative Questions

The following questions directed the approach to the problem:

1. What are the hourly rates and hours spent by A-E's inspecting projects?

2. What would be the comparable grade and hours to inspect the same projects by in-house inspection forces?

3. What are the costs and benefits of increasing the number of government inspectors versus hiring A-E's?

4. What are the specific requirements in the Statement of Work in government A-E contracts?

5. What requirements are missing that should be included in Air Force contracts?

6. What requirements in current contracts were the most beneficial?

Scope and Limitations

1. Only Air Force bases in the Continental United States (CONUS) are included in the survey.

2. This study is limited to Air Force base level inspection of construction projects.

3. While this study may touch on manning numbers and grades, manning is not the subject of this study and will not be discussed. Questions on this area are for cost comparison purposes only.

Background

The U.S. Air Force contracted with a team composed of Hanscomb Associates Inc. (HAI), BDM Corporation (BDM), and FRUCO Engineering Inc. (FRUCO) t. prepare an analysis of engineering functions. "The analysis is part of the Air Force 1986 Program for Project IMAGE (Innovative

Management Achieves Greater Effectiveness) which seeks to identify implementable improvements to the engineering functions and processes" (6:forward). One of the team's proposals was to study the cost effectiveness of Title II services. Title II services are defined as "those A-E services associated with the supervision and inspection of a project under construction" (3:1). The team of HAI, BDM, and FRUCO did not recommend changes in the current procedures necessarily, but stated that the process should be scrutinized and a statement of work (SOW) developed to provide as cost effective a contract as possible under current contracting law.

Literature Review

The first obstacle is to define Construction Management (CM) services. There are about as many different definitions as there are authors on the subject. The first definition is the one probably most important to Air Force Inspectors.

> It is during the construction phase that the efforts of programming, design, and contract award become the reality of a completed project. Regardless of the type of work-maintenance, repair, alteration, or construction of a new facility-it is essential that the construction contractor adhere to the approved plans and specifications to insure that the completed project provides a complete and usable facility that satisfies the requirement for which it was originally justified. In addition to assuring compliance with contract plans and specifications, inspections are performed to:
>
> a. Avoid extra construction costs beyond the approved construction contract amount.
> b. Identify unforeseen field conditions, errors in

drawings or technical specification. elements overlooked in final drawings or specifications, and to insure the early correction of same.
c. Maintain a daily record to provide accurate data for periodic reporting on contract status and construction progress and to establish written records of noncompliance or deviations from standards required to support Government (Air Force) position in litigation.
d. Eliminate the substitution of unacceptable materials, equipment, and craftmanship.
e. Prevent errors which might result in unnecessary and costly maintenance and upkeep costs.
f. Skillfully coordinate the work if more than one prime contractor is working on the same facility.
g. Protect the mutual interest of the Government (Air Force) and contractor to produce a desired coordination of interests.
h. Prevent unfair practices and procedures, or attempts at avoidance of contractual obligations.
The goal of the contract inspection effort is to assure the success of the construction project.
(2:13-1 to 13-2)

The following are two other examples of what is meant by Construction Management:

'Construction management services' means services that encompass a wide range of professional services relating to the management of a project during the pre-design, design, and construction phases. (These services are deemed to be 'professional' in accordance with 1-3.204 Personal or Professional Services.) The types of services include development of project strategy, design review relating to cost and time consequence, value engineering, budgeting, cost estimating, scheduling, monitoring of cost and schedule trends, procurement, observation to insure that workmanship and materials comply with plans and specifications, contract administration, labor relations, construction methodology and coordination, and other management efforts related to the acquisition of construction. (7:85)

Richard D. Conner provides a list of things he feels are included in Construction phase services.

*Conduct Preconstruction Conference
*Issue Notice to Proceed
*Assure Contractors' Insurance, Bonding, and Permit Requirements Are Met
*Provide Full-Time, Onsite Staff
*Provide Finance and Cost Control:
  * Change Order Administration
  * Administration of Progress Payments
  * Fund Source Allocation
*Administer Shop Drawings, Samples, and Other Submittals
*Schedule and Coordinate Contractors
*Conduct Job Coordination/Progress Meetings
*Establish and Administer Communication Lines between All Parties
*Maintain Job Records
*Provide Construction Observation
*Provide Technical Inspection
*Provide Prefinal and Final Inspections
*Secure Guarantees and As-Built Drawings
*Review and Coordinate Safety Program
*Provide Claims Documentation and Administration
*Provide Claims Negotiations and/or Assist in Litigations
*Assure Occupancy Permit

(1:21)

This type of service sounds appealing and the private sector has, in fact, been quite successful in using these services. "Unfortunately, the government owner [has] had a different experience from that of the private sector owner, primarily because of the rules, regulations, and restrictions that dominate federal procurement" (5:139). For instance, the fixed price contract that the government is fond of using puts the CM is an adversary role. The CM, instead of doing the best possible job to earn incentives, does the minimum required to meet contract requirements, while at the same time, the government is trying to squeeze every possible service it can from the A-E (5:141) Also, since the A-E CM has limited authority,

contractors soon learn that they really do not have to contend with the CM. They go directly to the government owner instead. (5:141)

There are several other difficulties associated with the use of A-E CM services. There is a long learning curve to teach the CM all the government procedures. Also, funding of CM contracts generally is not the same as for construction contracts. A delay in one can impact the other (5:142).

II. Methodolgy

Justification

The object of this thesis is to study the cost effectiveness of Architect-Engineer (A-E) Title II (inspection) services. The most direct way of collecting the costs associated with A-E services is to ask the people who would know the most about the costs of A-E Title II services: the Contracting Officer, the Administrative Contracting Officer of A-E contracts, the Chief of Engineering and Environmental Planning, and the Chief of Contract Management.

Instrument

A survey was sent to each of the four groups of people listed above. The questions in the survey fall into one of three broad areas: demographics, questions of facts, and questions of opinion.

There are four demographic questions. They ask for the Major Command (MAJCOM), grade/rank, office symbol, and position title. These four questions were primarily used to determine who answered, determine whether the use of A-E services (or non-use) was related to a MAJCOM, avoid duplicating data from the same base, and check for consistency of data from the same base.

The fact finding questions dealt primarily with collecting all the costs of using A-E inspection

services. Office of Management and Budgeting Circular A-76 states "The completed cost study will provide reasonable estimates of the cost of alternative courses of action. To assure a fair and equitable comparison, in-house cost estimates must be based on the same scope of work provided in the performance work statement and include estimates of all significant and measurable costs" (9:61). Based on this, all major costs associated with both A-E services and in-house inspectors were collected. Data included the actual cost of A-E inspection contracts and the cost of additional work required by the government to administer the contracts or to help the A-E with paperwork, find his way around the base, etc.

To compare the A-E inspection costs to the cost of in-house inspection, some of the questions were borderline fact/opinion. These questions asked the Chief Engineer and the Chief of Construction Management what level/grade inspector they would assign to inspect projects that were inspected by A-E inspectors, and how many hours it would take? They were to base their responses both in regard and without regard to current manning. Other costs collected were the costs of government vehicles and the cost to reimburse inspectors for using their own vehicles.

The remaining fact questions dealt with the A-E Title II contract itself. The questions asked how the A-E inspection contract was written and the type of

compensation used. Members of the population were also asked to provide a copy of their A-E contract to be used to determine the common elements in contracts.

The opinion questions were in two basic forms. There were eight questions using the Likert 5-point scale that explored the population's attitude toward the quality and process of using A-E inspection services. The other four opinion questions asked for up to three statements on the positive and negative impacts of A-E services and what to change to improve them.

The following section will present the planned course of action to write, validate and implement the survey used for this thesis. Then, the actual procedure that was used will be presented.

The initial plan for building the survey included these steps:

1. Write an initial draft of the survey
2. Pretest this draft with an offering of the Contract Preparation and Management, MGT 425 course.
3. Use the critiques to edit the survey to final form.
4. Obtain all applicable approvals for the survey.
5. Send the survey to all CONUS bases' to the four sections mentioned earlier.
6. Review the results and analyze the data.

Unfortunately, the process was not as simple as this. The following procedure is the one actually used and lists some of the problems faced.

1. Write an initial draft of the survey. The draft was based on the researcher's own experience with A-E inspection contracts while in Contract Management.

2. The draft was presented to the MGT 425 course on 11 December 1986. This step gave dismal results. Only one person who actually worked with the A-E contracts answered the survey, and his comments were minimal.

3. Pretested the survey again with the next MGT 425 class on 29 January 1987. The MGT 425 class provided little input. Only one person responded and again, his comments did little to enhance the survey.

4. Several bases from different Commands were called to find A-E Title II service users who would be willing to critique the survey. One base each from Strategic Air Command, Tactical Air Command, and Military Airlift Command volunteered to help. Of 12 surveys sent (one for each of the four different positions on each base), 4 were returned. These surveys proved to be the greatest source of feedback on the survey. However, the response still was not

sufficient to be considered good - merely adequate.

5. All three sets of critiques were used to edit the survey to final form.

6. The survey was approved by the various base level agencies and MPC.

7. The surveys were sent to the four sections mentioned earlier to 79 CONUS bases and responses started returning within a week. After six weeks, no more responses were accepted to allow the beginning of analysis.

Sample/Population

In order to find facts related to, and opinions concerning, A-E inspection services, it was desirable to reach the population which would have the greatest knowledge of this area. So the people who consistently deal with A-Es the most were chosen: the Contracting Officer (CO), the Administrative Contracting Officer of A-E contracts (ACO), the Chief of Engineering and Environmental Planning (DEE), and the Chief of Contract Management (DEEC) at all Conus bases. With 79 bases, this yielded a population of 316. Since the pretest of the survey indicated that the use of A-E inspection services might not be very widespread, a census was performed. This would provide enough responses numerically so there would be enough data to analyze. Also, it would be easier to pick out trends in the Air Force by MAJCOMS, location,

etc. Four surveys were sent to each base that (there were only slight differences between the Contracting and Engineering surveys) to increase the chance that at least one of the four recipients would respond.

Data Analysis Plan

The analysis, like the survey, was broken into three main areas. Trends that relate to demographics were studied. The costs of A-E versus in-house inspection were compared. The attitudes toward the use of A-E inspection were analyzed. All statistical analysis was performed using SPSSx, the Statistical Package for Social Sciences. Procedures such as frequencies, histograms, cross-tabulation, linear regression, and t-test were used for the analysis.

Demographics. The main purpose is to relate the use of A-E inspection services to Major Commands. This section was used to determine how knowledgable the population was on the topic of A-E Title II services.

Facts/Costs. All major cost factors for A-E inspection services were collected and adjusted by an inflation factor and an economic adjustment factor (see Appendix C). The data was then analyzed for several different items.

1. The A-E inspection contract cost was compared to the construction contract cost and stated as a percentage.

2. The cost per hour of A-E inspection services was calculated and included all costs associated with A-E inspection (See Appendix E).

3. Two simple linear regressions were performed. The first related the cost of A-E inspection services to the cost of the construction project. The second related the ratio of inspection cost to construction cost with construction cost. This is to provide a guide to prospective users of A-E inspection services as to whether they are "in the ballpark" with their cost estimates.

All major costs were also collected for in-house inspectors. The respondents provided the grade/level of an inspector they would realistically assign, and would like to assign, to the projects that the A-Es inspected. Then they provided the number of hours the inspector would realistically spend inspecting the same project as well as the number of hours they would like the inspector on the project. These two sets of information (realistic according to current manning and their desire without constraint) were used to calculate the hourly cost of in-house inspectors to perform the same work as the A-E.

The costs for A-E inspection and the costs for in-house inspection were put in several different forms that could be compared directly. The costs were put in units of dollars per manhour, dollars per day, and annual cost. A t-test was performed to see if there was a

significant difference between the A-E and in-house inspection costs. Finally, a simple table was compiled to easily show the critical number of hours of inspection which would indicate whether to use A-E or in-house inspectors.

Opinion Questions The final section discussed is the attitude of the respondents toward the use of A-E inspection services. A 5-point Likert scale was used and gave the options of: 1-strongly agree, 2-agree, 3-neutral, 4-disagree, 5-strongly disagree.

The first grouping of questions asked the following questions:

1. The A-Es you have used are more qualified than in-house inspectors.
2. When there are A-E inspection services, it is better to have A-E supervision services as well.
3. A-E inspectors do a better job of inspection than in-house inspectors.
4. If a project is going to an A-E, the same A-E should do everything. This would include pre-design, design, supervision, and construction inspection.
5. The same A-E firm used for design and construction inspection will tend to overlook design errors during the construction phase.
6. A-Es should be given a bonus for providing good inspection services.

This group of questions was analyzed by looking at the means and distributions of the responses for any significant trends.

The second group of opinion questions was four open-answer questions. They are:

1. List up to 3 requirements in the A-E Title II contracts that have proven to be valuable.
2. List up to 3 benefits you have received from using A-E Title II contracts.
3. List up to 3 problems or difficulties that resulted from using A-E Title II contracts.
4. List up to 3 items you didn't include in your contracts and either wish you had or wish you were able to include.

The responses were categorized based on similarity of the statements made. In some cases, the categories became fairly broad. These cases are noted in the analysis chapter. The conclusions drawn from these questions were used to edit the A-E inspection contracts which were provided by the respondents. The outcome is a sample statement-of-work that encompasses the more commonly expressed opinions.

Assumptions and Limitations

A survey that allows as much freedom in answering it as this one, leaves a wide range of possible responses. Answers ranged from non-existent to cryptic to

concise to superfluous. Because of this, I analyzed the information based on these rules:

1. If at all possible, the responses were taken at face value. Some responses appeared to be in error, but without knowing for sure, they were included. Only gross errors, of which there was only one, were eliminated.
2. If a person responded that they did not or had not used A-E inspection services, their responses on the rest of the survey were disregarded.
3. Responses from people not in the population were disregarded.
4. Regarding question number 13. This question was "Please provide the following information on your most recent A-E Title II contracts: the fiscal year of the contract, contract price of the CONSTRUCTION PROJECT, the contract period of the CONSTRUCTION PROJECT (in days), number of inspection manhours for the contracts, cost of inspection services." If the respondent did not answer in the appropriate units of measure (i.e., manhours, dollars) the responses were not used to calculate the cost per manhour of A-E inspection service and the percentage of A-E inspection cost to construction contract cost. For example, some respondents listed A-E inspection time in days. But what constitutes a day? Does the A-E

work 2 hours per day, eight hours per day, or two people for eight hours per day? To avoid assuming too much (or too little), these responses were not used.

5. Similar to 4 above, data on the length of the construction contract was accepted in terms of months, but not in terms of years. The unit of months was accurate enough to establish the length of the construction contract. All contract lengths were assumed to be calendar days and not workdays. To convert, the construction project duration was multiplied by five-sevenths (five work-days in seven calendar days). This was used to determine the number of days the A-E inspector inspected the construction project.

6. The number of responses on open-answer type questions normally ranged from zero to three. However, if more responses were provided, they were used.

7. Information provided from a base was used even if there was a disagreement between respondents from the same base as to whether or not A-E inspection services were used.

8. One base's responses were included in the "did not and have not used" category even though they indicated that A-E services had at one time been

used. The service was provided 7-9 years ago (1980 or 1978) and the respondents had very limited knowledge of the inspection service.

9. Answers to question number 13 (see assumption number 4) which were duplicated by several people from the same base were used only once. Only obvious duplicates were disregarded.

10. Responses that were very cryptic or simply did not make sense were disregarded.

III. Findings and Analysis

Introduction

This chapter presents each question from the surveys and the answers to them. (The complete surveys and cover letters are found in Appendix G) Question numbers are listed in the following form: Question #/#. The first number is the question number on the survey sent to Engineering. The second number is the question number on the survey sent to Contracting. If one number is missing, the question was not on the Engineering/Contracting survey. After the presentation of results, there is the analysis of A-E inspection costs for a linear regression model. Then, tests for difference of means are conducted on A-E and in-house inspection costs. An analysis of the opinion questions follows and finally, the input for a guide Statement of Work is used to create such a guide.

Results

The Chief Engineer (DEE), the Chief of Contract Management (DEEC), the Contracting Officer (CO), and the Administrative Contraction Officer for A-E contracts (ACO) at 79 CONUS bases were each sent a survey for a total of 316 surveys. Of these, 177 surveys were returned for a 56% return rate. The responses were relatively evenly distributed between the four positions (Table I.) as well as between commands (Table II), considering the relative number of bases in each command.

Table I. Number of Responses by Position

Position	Responses	Valid %
DEE	50	28.4
DEEC	40	22.7
CO	41	23.3
ACO	45	25.6
Unknown	1	

Table II. Responses by MAJCOM

Command	Responses	Valid %
AFDW	3	1.7
AFLC	9	5.1
AFSC	12	6.8
ATC	24	13.6
AU	4	2.3
MAC	23	14.2
SAC	59	33.5
TAC	41	23.3

The surveyees were asked the following yes or no questions: "Has your base used, or does if now have any A-E Supervision and Inspection (Title II) contracts?" The respondents answering no were asked to provide the reason, or their best judgement, why the base did not use A-Es for inspection. Table III shows the breakdown of yes and no answers by MAJCOM.

Table III. Number of Yes and No Responses by MAJCOM

Command	Yes	No
AFDW	3	0
AFLC	5	4
AFSC	2	10
ATC	2	22
AU	0	4
MAC	13	12
SAC	21	38
TAC	17	24
Total	63	114

The most common responses why the base does not or had not used A-E services are listed below. There was no restriction on the number of answers allowed.

1. The base does the inspection / they are adequately staffed / no need for A-E inspection services (40.1%)
2. A-E inspection is too expensive / can't get the funds (10.6%)
3. A-E does poor quality work / in-house does better inspection (7.7%)
4. Use overhires / borrow personnel from other sections (3.5%)
5. Planning on using A-Es in near future (4.9%)
6. Miscellaneous (15.6%)
7. No response (17.6%)

Presenting the data in this form hides a significant trend in the answers. There were many bases that answered both yes and no to the question of whether they presently, or had, used A-E inspection services. Table V categorizes the responses as yes - all respondents from a base said they had or did use A-E inspection, yes/no - respondents from a base did not concur on the use of A-E inspection, or no - all respondents from a base said they did not or had not use A-E inspection services.

Table IV. Number of Yes, Yes/No, and No Responses

Command	Yes	Yes/No	No
AFDW	2	0	0
AFLC	3	2	1
AFSC	0	2	4
ATC	2	1	10
AU	0	0	1
MAC	4	1	4
SAC	3	11	8
TAC	4	6	6
Total	18	23	34
Percent	24.0	30.7	45.3

The reasons behind this aberration are not explored by this thesis; however, it seems obvious that the effective use of A-E inspections would be greatly inhibited when the key people who use A-E inspection services do not know if they are using them or not.

Question 6/6. What guidance did you have to help you write your A-E Title II contracts?

Table V. Responses to Question 6/6

Choice	Response	Percent
Regulation	17	19.5
Standardized format	17	19.5
Copies form other bases	8	9.2
Past contracts of your own	12	13.8
Did the best you could	24	27.6
Other	9	10.4

The grouping "other" included responses such as: "received help from the AFRCE", "don't know", "and didn't write it [the statement of work]".

Question 7/7. The Air Force should have a REGULATION on writing A-E Title II contracts

Table VI. Responses to Question 7/7

Response	Value	Frequency	Percent
strongly agree	1	26	44.8
agree	2	17	29.3
neutral	3	7	12.1
disagree	4	6	10.3
strongly disagree	5	2	3.5

Nearly three-fourths (74.1%) of the respondents agreed or strongly agreed that a regulation was needed. The mean of all answers was 1.983, which falls almost exactly on the agree response.

Question 8/8. The Air Force should have a standardized format as a GUIDE to write A-E Title II contracts.

Table VII. Responses to Question 8/8

Response	Value	Frequency	Percent
strongly agree	1	28	47.5
agree	2	22	37.3
neutral	3	6	10.2
disagree	4	3	5.0
strongly disagree	5	0	0

There was an even stronger response in favor of a guide with 84.8% of the respondents agreeing or strongly agreeing with the need for the guide. The mean of all responses is 1.729, which is between agree and strongly agree.

Question 7 versus Question 8. There was slightly more favoritism toward having a guide rather than a regulation for writing A-E inspections specifications. However, both questions show the desire of the population

to have more help in this area. (pearson correlation = .5241, p-value = .000)

Question 9/9. What type of compensation arrangement are you using?

Table VIII. Responses to Question 9/9

Response	Frequency	Percent
Negotiated firm-fixed-price lump sum	42	73.7
Firm-fixed-price based on percent of construction cost	6	10.5
Labor hour	6	10.5
Cost Reimbursement	1	1.8
Other	2	3.5

Question 10/10. What do you feel would be the BEST compensation arrangement for A-E Title II contracts?

Table IX. Responses to Question 10/10

Response	Frequency	Percent
Negotiated firm-fixed-price lump sum	39	67.2
Firm-fixed-price based on percent of construction cost	5	8.6
Labor hour	7	12.1
Cost Reimbursement	3	5.2
Other	4	6.9

Question 11/11. Are you using indefinite-delivery-indefinite-quantity (IDIQ) (open-end) A-E Title II contracts?

Table X. Responses to Question 11/11

Choice	Response	Percent
yes	19	32.2
no	40	67.8

Question 12/12. The A-E's you have used are more qualified than in-house inspectors.

Table XI. Response to Question 12/12

Response	Value	Frequency	Percent
strongly agree	1	11	18.6
agree	2	16	27.1
neutral	3	12	20.3
disagree	4	15	25.4
strongly disagree	5	5	8.6

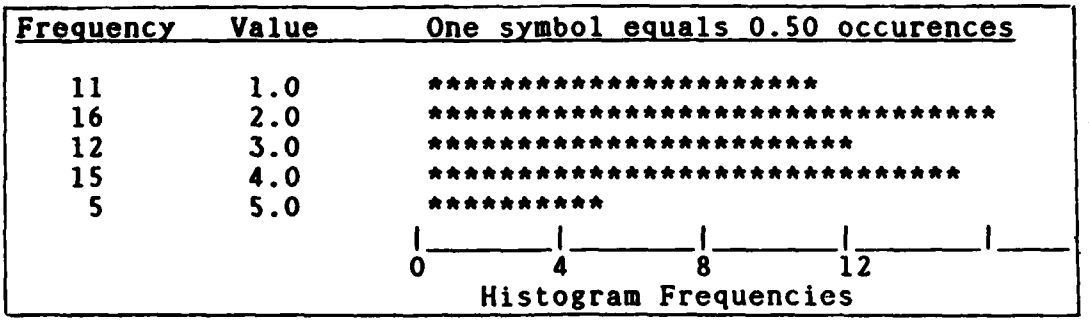

Figure 1. Histogram for Question 12/12

Even though the mean of 2.780 shows slight agreement with the statement, it is very close to neutral. The histogram also shows the relatively even distribution of opinions across the range of values

Question 13/13. Please provide the following information on your most recent A-E Title II contracts: the fiscal year of the contract, contract price of the CONSTRUCTION PROJECT, the contract period of the CONSTRUCTION PROJECT (in days), number of inspection manhours for the contracts, cost of inspection services.

This data is used very extensively in later sections. The following is a brief summary of the responses.

Information in this table has been adjusted by inflation and economic adjustment factors as listed in the Means Building Construction Cost Data (9:332-341).(see Appendix C)

Table XII. Summary of Responses for Question 13/13

	Mean	Median	Minimum	Maximum
Fiscal Year			82	87
Cost of Project	2951772	1140211	4846	10879994
Length of Project	264	165	60	840
MHs of Inspection	1090	537	40	3856
Cost of Inspection	66754	40066	1723	289587

Construction project costs, inspection costs, and percent of inspection cost to construction cost are listed in Appendix F.

Question 14/ . For the above projects, what grade level of inspector would have been assigned based on the manning level of CM?

Table XIII. Response to Question 14/

	Military	Civilian
Range	E-5 to E-8	GS-6 to GS-11/12
Mode	E-5	GS-9
Median	E-5	GS-8/9
Responses	13	20

Question 15/ . For the above projects, what grade level of inspector should have been assigned to perform adequate inspection?

Table XIV. Response to Question 15/

	Military	Civilian
Range	E-5 to E-8	GS-8 to GS-12
Mode	E-6	GS-11
Median	E-6	GS-9/11
Responses	8	25

Question 16/ . How many hours per day would these inspectors realistically work on these particular projects?

Table XV. Response to Question 16/

Range	0.2 to 8
Mode	2
Median	3
Mean	3.748

Question 17/ . If this would not be enough hours to inspect the project as thoroughly as an A-E, how many hours per day would it take?

Table XVI. Response to Question 17/

Range	0.8 to 10
Mode	8
Median	7
Mean	5.706

Question 18/14. Do your A-E Title II contracts include hours for supervision services (for things like submittal review, as-built drawing preparation, testing, modifications) or traveling time to and from the job site?

Table XVII. Response to Question 18/14

Choice	Response	Percent
Yes	38	65.5
No	20	34.5

inspection services.

Question 19/15. If yes, how many hours per project at what cost? (Even if your contract was negotiated as a lump sum, please list the services you included)

The response to this question was very sparse. The most common responses were:

Table XVIII. Response to Question 19/15

Response	Frequency	Percent
Travel	7	17.9
Submittal Review	5	12.8
Shop Drawings/As-builts/Drafting	5	12.8
Engineering/Project Engineer/Modifications	5	12.8
Testing/Laboratory work	3	7.7
Project Manager/Const. Manager/Supervision	3	7.7
Specialists (Geotechnical and Corrosion)	2	5.1

These 30 responses accounted for 77% of all responses. The form of many of the responses is such that an estimate for the cost of these items would be meaningless.

Question 20/16. When there are A-E inspection services, it is better to have A-E supervision services as well.

Table XIX. Response to Question 20/16

Response	Value	Frequency	Percent
strongly agree	1	7	13.0
agree	2	13	24.1
neutral	3	20	37.0
disagree	4	11	20.4
strongly disagree	5	3	5.5

The mean value is 2.815, which is very close to being a neutral opinion.

The responses to this question were crosstabulated with responses from question 18/14.

Those whose contracts included supervision services agreed slightly more that it is better to include A-E supervision services with A-E inspection services. However, both groups are still very near to having a neutral opinion of supervision services.

Table XX. Crosstabulation of Questions 18/14 and 20/16

		Question 20/16						
		Likert Scale						
		1	2	3	4	5	Total	Mean
Question 18/14	Yes	4	9	15	5	1	34	2.706
	No	3	4	5	5	2	19	2.947
Total		7	13	20	10	3	53	2.815

Question 21/17. List up to 3 requirements in the A-E Title II contracts that have proven to be valuable.

There were a total of 69 responses from 31 people with the most common responses listed below:

Table XXI. Response to Question 21/17

Response	Frequency	Percent
Closer inspection/full time inspection	12	17.4
Submittals	10	14.5
Change Orders/cost estimates	10	14.5
More knowledge/expertise	8	11.6
Reports-Progress/contractor problems	5	7.2
As-builts/shop drawings preparation and review	4	5.8
Daily logs	2	2.9
		73.9

Question 22/18. List up to 3 benefits you have received from using A-E Title II contracts.

There were a total of 73 responses from 28 people. The most common responses are listed below.

Table XXII. Response to Question 22/18

Response	Frequency	Percent
Better inspection/more expertise/knowledge	17	23.3
Workload/frees in-house inspectors/ limited manpower	10	13.7
A-E full-time inspection/detailed	10	13.7
Change orders/negotiation/ modifications and costs	5	6.8
Testing - quicker	4	5.5
Material and submittal approval	2	2.7
		65.7

Question 23/19. List up to 3 problems or difficulties that resulted from using A-E Title II contracts.

A total of 36 people provided 74 responses to this statement. The most common responses are:

Table XXIII. Response to Question 23/19

Response	Frequency	Percent
Slow/poor paperwork (submittals,reports,closeouts)	11	14.9
Ignore/overlook/hide design deficiencies	9	12.2
Bad job/unreliable/poorly trained	8	10.8
Doesn't understand procedures/confused	7	9.5
Cost high/excessive/prohibitive	7	9.5
Surveillance of A-E needed	4	5.4
Getting along with the CO and Base Engineer	3	4.1
Lack of communication	3	4.1
		70.5

Question 24/20. List up to 3 items you didn't include in your contracts and either wish you had or wish you were able to include.

Only 14 people provided 25 responses to this statement. Most of the responses dealt with a specific problem that base had encountered. Two of the more common responses were:

Table XXIV. Response to Question 24/20

Response	Frequency	Percent
Tighter control on A-E/better written SOW	8	32
Minimum qualification for inspector	3	12
		44

Question25/23. Have you had times when the A-E inspector did not work due to funding problems with the A-E contracts? (i.e. change order, end of fiscal year, etc.)

Table XXV Response to Question 25/23

Response	Frequency	Percent
Yes	7	15.6
No	38	84.4

Question 26/24. If yes, list up to 3 examples and state the impact.

Five people answered this question, but they merely reiterated that there were funding problems either because the A-E funds ran out before the construction project was over, or a new fiscal year began. The only impact listed was dissension between Contracting and Civil Engineering. No reasons were provided as to what caused this dissension.

Question 27/25. What can be done to change this? There were only four responses. They were:

1. A tighter A-E contract - to cover knowns and future unknowns which may surface during construction.

2. Hire more inspectors at better grades in order to obtain better qualified personnel that will stay in place and not want to leave do[sic] to better positions elsewhere.

3. Give the CM limited contracting authority.

4. Make A-E funding non-year funds.

Question 28/26. A-E inspectors do a better job of inspection than in-house inspectors.

Table XXVI. Response to Question 28/26

Response	Value	Frequency	Percent
strongly agree	1	7	13.0
agree	2	14	25.9
neutral	3	14	25.9
disagree	4	10	18.5
strongly disagree	5	9	16.7

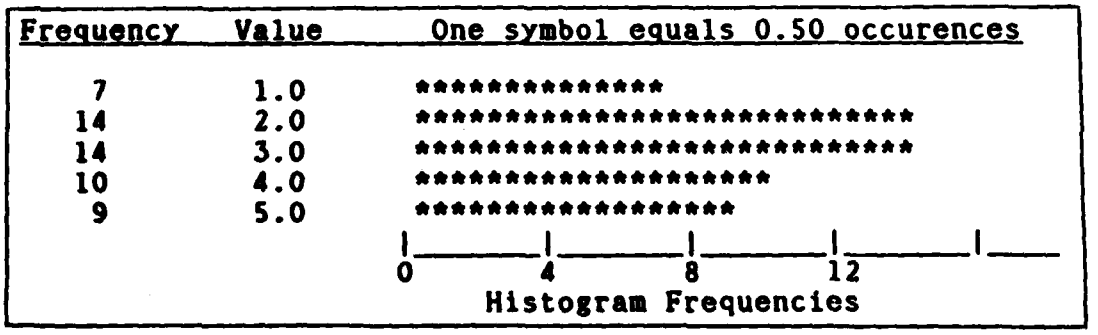

Figure 2. Histogram of Responses for Question 28/26

The mean for this question is 3.000. By looking at the histogram, it is apparent that there is a wide range of opinion (standard deviation equals 1.289).

Question 29/27. IF a project is going to an A-E, the same A-E should do everything. This would include pre-design, design, supervision, and construction inspection.

Table XXVII. Response to Question 29/27

Choice	Value	Response	Percent
strongly agree	1	13	23.2
agree	2	18	32.1
neutral	3	6	10.7
disagree	4	10	17.9
strongly disagree	5	9	16.1

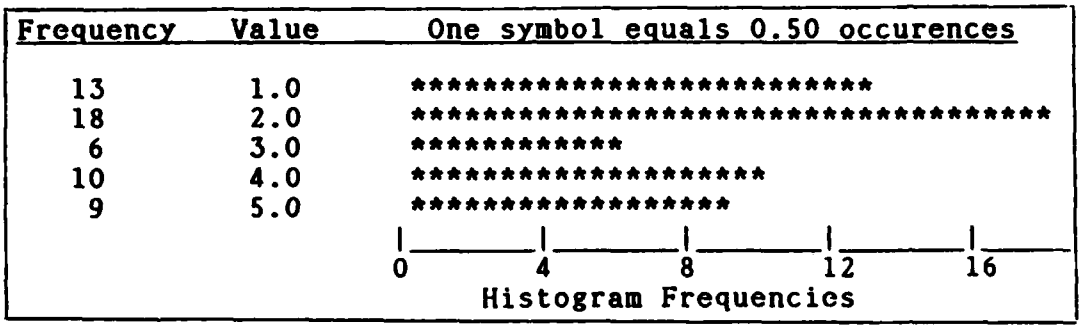

Figure 3. Histogram of Responses to Question 29/27

The mean of 2.714 shows slight agreement with this question. However, the standard deviation of 1.434 as well as the histogram show a wide range of feeling.

Question 30/28. The same A-E firm used for design and construction inspection will tend to overlook design errors during the construction phase.

Table XXVIII. Response to Question 30/28

Choice	Value	Response	Percent
strongly agree	1	7	12.5
agree	2	18	32.1
neutral	3	12	21.4
disagree	4	18	32.1
strongly disagree	5	1	1.8

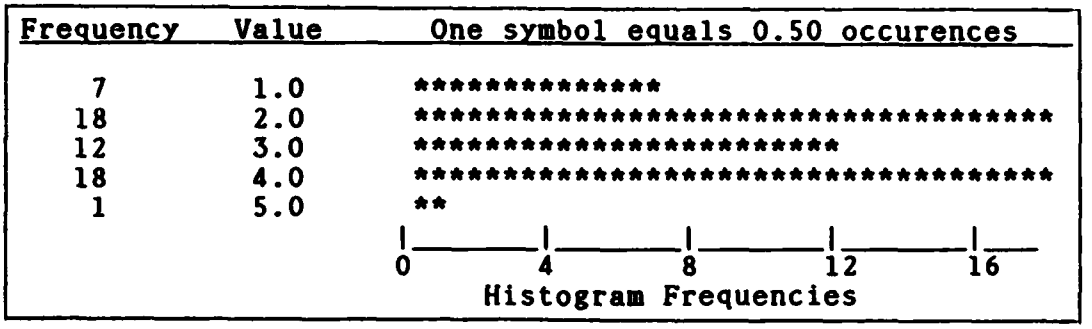

Figure 4. Histogram of Responses to Question 30/28

Once again, the mean of 2.786 is very near a neutral opinion for this question.

Question 31/29. A-E's should be given a bonus for providing good inspection services.

Table XXIX. Response to Question 31/29

Choice	Value	Response	Percent
strongly agree	1	2	3.6
agree	2	12	21.4
neutral	3	11	19.6
disagree	4	21	37.5
strongly disagree	5	10	17.9

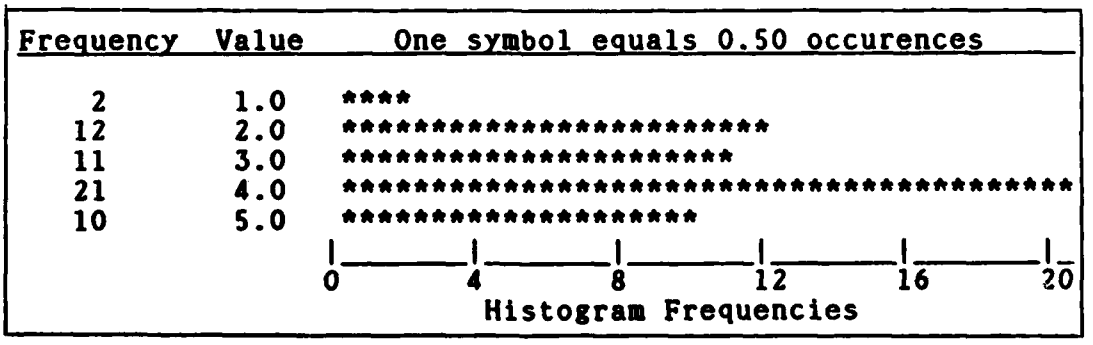

Figure 5. Histogram of Responses to Question 31/29

The mean of 3.446 indicates a tendency to disagree with this statement. The tendency is not strong, but exists nonetheless.

Analysis of Opinion Questions

Questions 12, 20/16, 28/26, 29/27, and 30/28 all have means very close to neutral (3). Looking at the range of values, these answers seem to indicate that there is a wide range of quality in A-E services available.

The only question that varied was question 31/29 which had a mean of 3.446. More people felt that A-Es should not receive a bonus for doing good work. This may be because engineers expect other engineers to do professional work to begin with.

Linear Regression Model

One aspect of A-E inspection services that is important, especially to those who have not used Title II services before, is an idea of how much one should pay for A-E inspection services. The following section walks through the linear regression analysis performed on the A-E inspection costs versus the construction costs. Each of the different approaches used is explained, and a final recommendation presented.

The first step is to plot inspection cost of a project versus the construction cost of that project. (Figure 6) Linear regression is performed and yields a line with this equation:

$$Y = 25007 + 13.89X \qquad (1)$$

where

Y = the inspection cost ($)

X = construction cost in $1,000

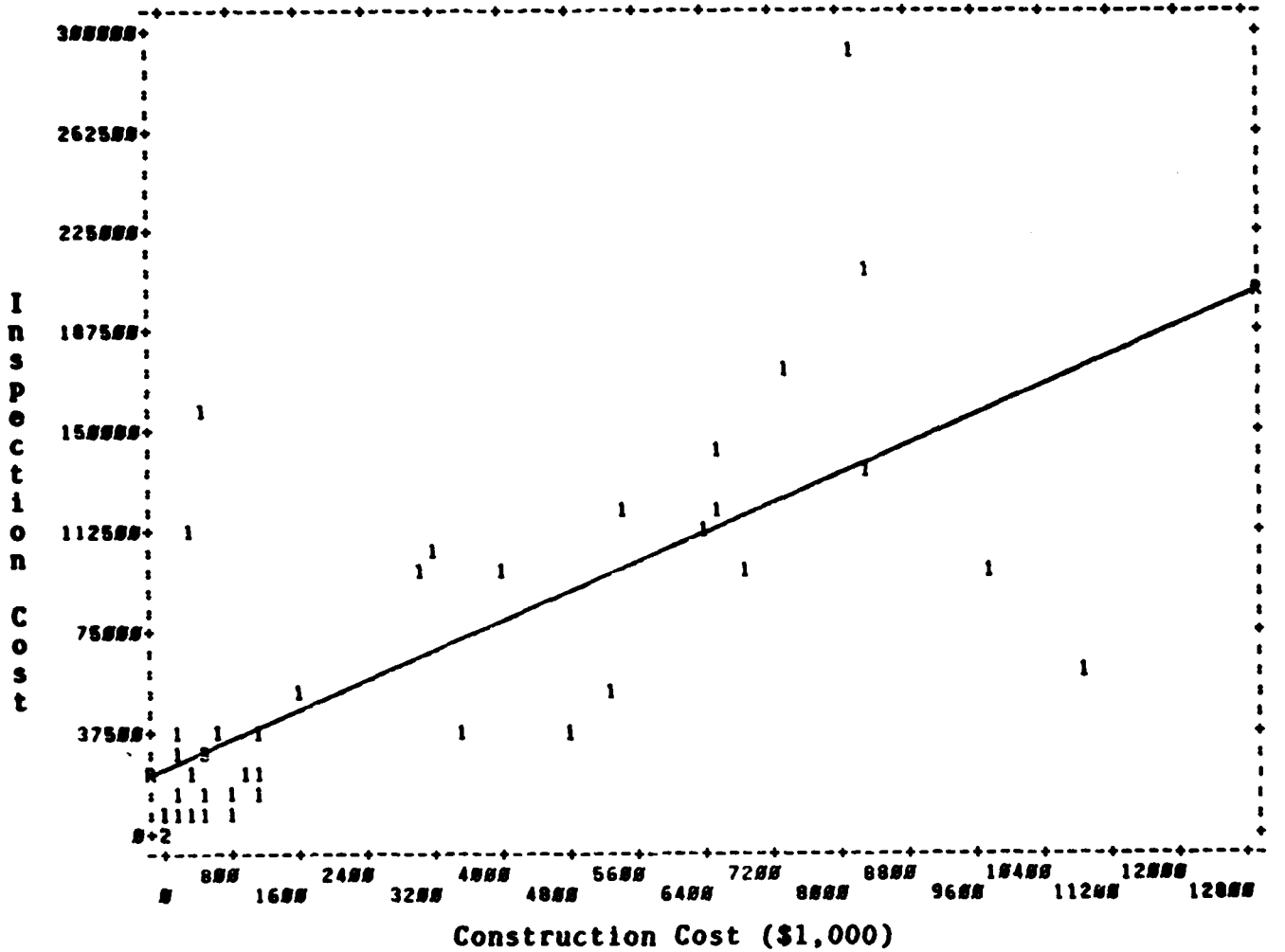

Figure 6. Inspection Cost versus Construction Cost ($1,000)

The line has a correlation of 0.69974, an r-squared of 0.48964 and a significance of 0.0000. Initially, this line seems to be a good guide for inspection costs, but there is one major problem. For small construction cost values, the inspection costs are relatively high. Another way to put this is that the ratio of inspection cost to construction cost goes to infinity as the construction cost goes to zero.

One more attempt was made to get a good regression line for this data. The ratio of inspection cost to construction cost was calculated for all points and stated as a percentage. Five of these percentages were considerably different from the rest, with values of 39.5, 36.8, 35.6, 31.6, and 25.4. These contrast with the remainder of the percentages which range from around 1% to 9%. The data associated with these five percentages were considered outliers and removed from the analysis. The new regression line has the equation

$$Y = 14312 + 15.41X \qquad (2)$$

where

Y = the inspection cost ($)

X = construction cost in $1,000

with a correlation of 0.77472, and r-squared of 0.60019, and two tailed significance of 0.0000. This new equation is as statistically significant as the first, but more practical at lower construction costs. Even though small

values for construction cost still yield unruly numbers for inspection cost, the ratio of inspection cost to construction cost becomes "reasonable" sooner than the first equation.

The repeated occurence of the ratio of inspection cost to construction cost prompted a new analysis using the ratio of inspection cost to construction cost (hereafter, "the ratio") to the construction cost. The plot of these two variables is shown in Figure 7. Simply by inspection, it appears obvious that one straightline through this data would have little practical significance. (For a construction cost slightly over $8,000,000, the inspection cost goes to $0.)

Several different groupings were used to look for a natural breakpoint which might be present. It was found that for construction costs between $0 and $2,000,000, there is no practically significant regression line. The variability of the data in this region is simply too high.

The two best lines from a statistical and practical viewpoint are presented below. The first line arbitrarily deletes all ratios greater than 10% and has the following equation:

$$Y = 3.816 - 0.000284X \quad (3)$$

where

Y = ratio of inspection to construction cost (percentage)

X = construction cost in $1,000

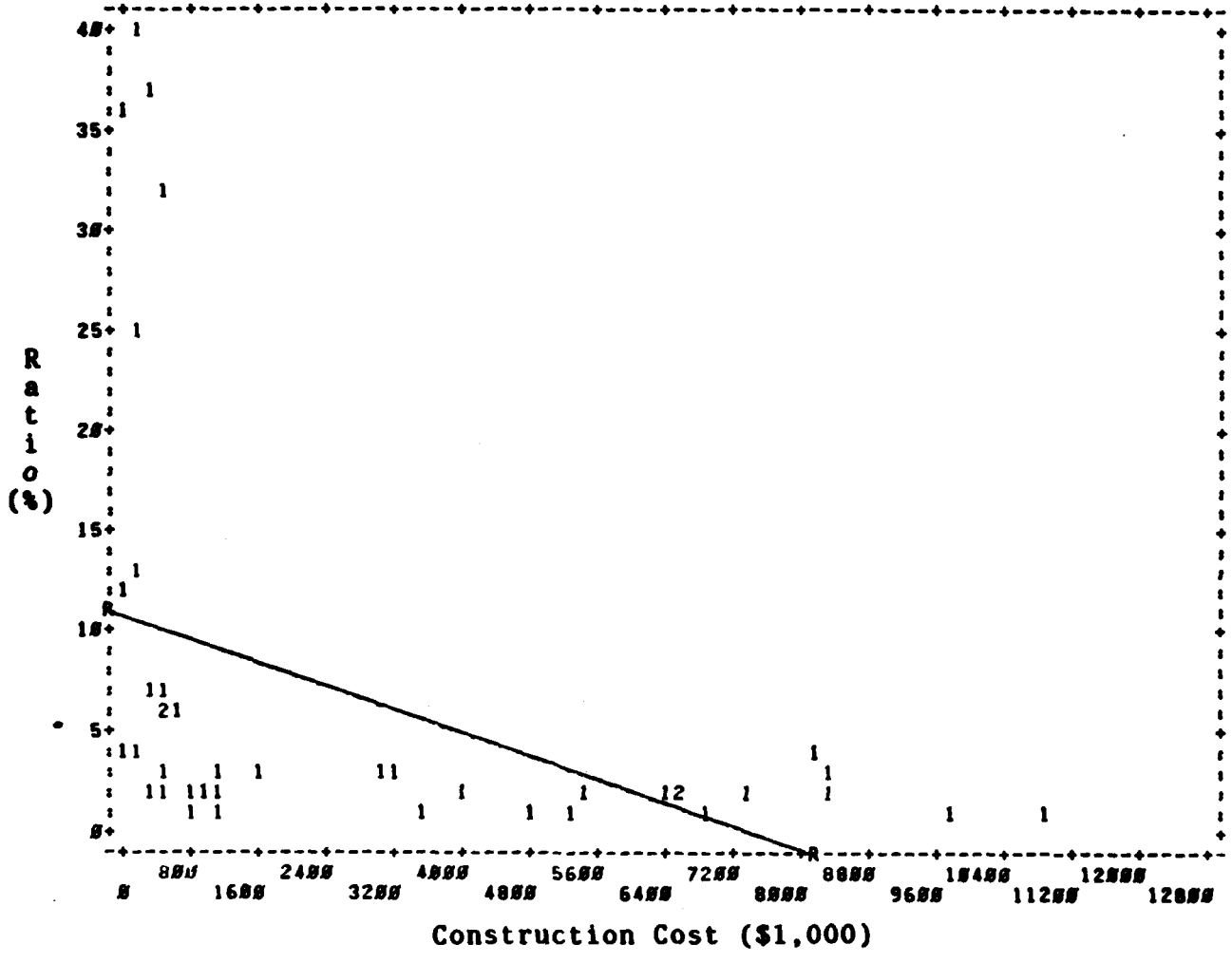

Figure 7. Ratio (%) of Inspection Cost to Construction Cost versus Construction Cost ($1,000)

This line has a correlation of -0.51227, an r-squared of 0.26242 and a two-tailed significance of 0.0020.

While this line represents the relationship moderately well, it is disturbing to arbitrarily remove possibly valid points simply because they are inconvenient.

The next model ranges in construction costs from $1,000,000 to $10,800,000 (the maximum construction cost). This will provide an equation for the line which is valid only in this region. This impacts in two ways. First, it removes the arbitrary deletion of points. On the other hand, it does not discuss the points below $1,000,000 construction cost and is not valid below that limit. In any case, the line is somewhat flatter and has the following equation:

$$Y = 2.6554 - 0.000115X \qquad (4)$$

where

Y = ratio of inspection to construction cost (percentage)

X = construction cost in $1,000

This line has a correlation of -0.35658, and r-squared of 0.12715, and a two-tailed significance of 0.1126. Overall, this is statistically weaker than the previous model. The null hypothesis being tested is that the slope of the line is zero. This high of a significance level says that, for instance, one would be less than 90%

sure of disproving the null hypothesis. This makes sense, because the line is almost flat (slope = -0.000115).

Another approach used was to assume the relationship of the ratio to construction cost was not linear. The plot of the data led the researcher to believe that a logarithmic transformation of the ratio data would yield better results. The natural logarithm was chosen . (As it turns out, either a natural logarithm or log base 10 yields exactly the same results in the linear regression model.) Transforming the ratio data (y-axis) and performing a linear regression yields a line whose equation is

$$Y^* = 1.8121 - .000195X \qquad (5)$$

where

Y^* = the natural log of the ratio of inspection cost to construction cost

X = construction cost in $1,000

Transforming back to a linear scale, the equation of the curve is

$$Y = e^{(1.8121 - 0.000195X)} \qquad (6)$$

where

Y = the ratio of inspection of construction cost

X = construction cost in $1,000

The correlation is -0.57148, r-squared is 0.32659, and a two-tailed significance of 0.0001. (see Figure 8)

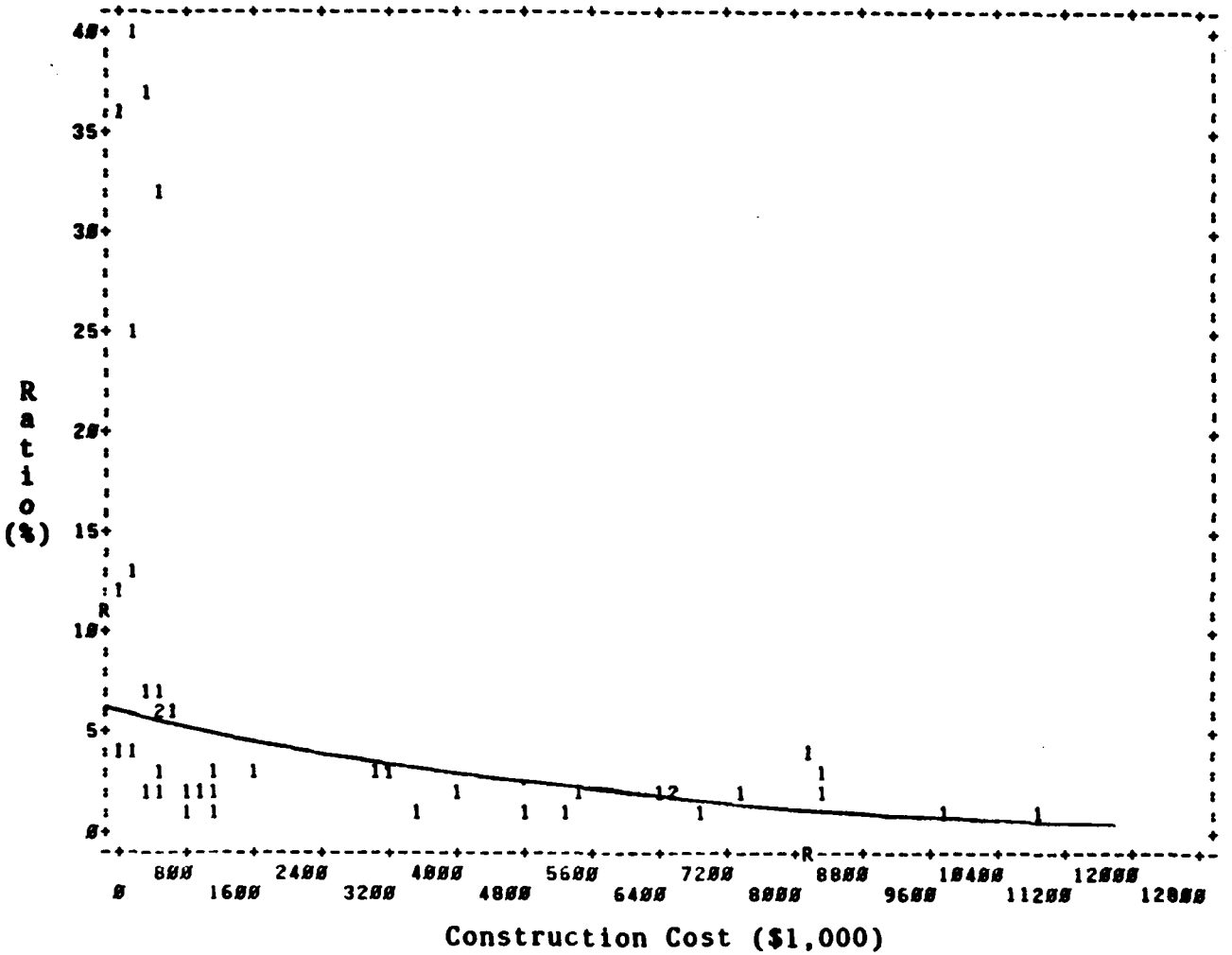

Figure 8. Ratio (%) of Inspection Cost to Construction Cost versus Construction Cost ($1,000) with Regression Curve

Of the three equations presented to represent the relationship of the ratios to the construction cost, equation (6) is both more practically and statistically significant than the other two. The strengths of this equation are the elimination of the phenomenon of the regression line crossing the x-axis within the range of concern ($0 to $10,800,000). The significance of the regression line crossing the x-axis is it implies that for some construction cost, the ratio is zero; or more clearly, one receives free inspection service. From a practical standpoint, this can not be. Another strength is that this model uses all of the data, not just a few selected points. A drawback is the equation is more difficult than a simple linear equation, and may frighten some people off. To reiterate a point made earlier, in the range of construction costs below $1,000,000, this model rapidly looses practical significance. There are apparently too many other factors that effect the cost in this region.

The recommendation for estimating the percentage of inspection cost to construction cost for a given construction is equation (6).

Test for Difference of Means

Another important segment of this analysis is a comparison of the costs associated with A-E inspection

services with the costs of performing the inspections using in-house inspection personnel.

This section steps through the procedures used to compare the costs, with significant equations and assumptions reserved for appendix E.

As presented earlier in this chapter, the population was asked a series of questions to collect the major costs of both A-E inspection and in-house inspection for the same project. Question 13 of the survey asked for the fiscal year, construction cost, construction period, A-E cost, and manhours of A-E inspection for each base's most recent A-E Title II contracts. The first step was to adjust all dollar figures for inflation and then adjust them by an economic factor based on location. The inspection cost for A-E inspection services and the manhours of inspection, along with the time required by contracting personnel to administer the contracts and time required by engineering personnel to help the A-E inspector were all used to derive and hourly cost for A-E inspection of $44.07 with a standard deviation of 17.83 (n=19).

The cost of an in-house inspector is somewhat more difficult to derive. Also, throughout this discussion, there are two sets of costs which will be used. One set reflects the grade and hours an in-house inspector would realistically inspect the project (group 1). The other

set is the cost to inspect if the responder (DEE or DEEC) could assign inspectors without respect for manning levels or time the inspector spent on the project (group 2). Also factored in was the cost for additional vehicle(s) for the in-house inspector. Group 1 had a mean of $17.54 with a standard deviation of 2.795 (n=30). Group 2 had a mean of $20.64 with a standard deviation of 3.514 (n=30).

A t-test of means was conducted to determine if the mean of the A-E inspection cost versus the mean of the group 1 in-house costs was significantly different. The T-value of -6.44 (p-value =0.0000) indicates a significant difference in means. A similar test was performed using A-E versus group 2 means. Again, there is a significant difference in means (T-value = -5.66, p-value = 0.0000). These tests indicate that even if the Chief Engineer or Chief of Construction Management could hire any grade inspector they felt they needed, the hourly cost would still be significantly less than the cost of hiring an A-E. But there is a problem with directly comparing hourly costs. For the most part, the respondents felt it would take in-house personnel longer to perform the same level of inspection as an A-E inspector.

To obtain a more realistic comparison, the means of daily costs were compared. The hours per day for the A-E inspectors were estimated (see appendix E) and daily costs of both the A-E and in-house inspectors computed. The mean A-E daily cost is $197.17 with a standard

deviation of 142.11 (n=19). Group 1 daily rate is $67.86, standard deviation = 49.204, n=30, and group 2 daily rate is $118.60, standard deviation = 63.032, n=30.

The t-test of difference of means for A-E daily cost versus group 1 daily cost yielded a T-value of -3.82, d.f. = 20.76, p-value = 0.0005, still a very significant difference. The test between A-E and group 2 daily costs yielded a T-value of -2.27, d.f. = 22.55, p-value = 0.0165. Again, with a high degree of certainty, the daily cost of in-house inspection based on manning and hours per day without regard to manning levels or work load is significantly less than the daily cost for an A-E inspector.

There is still a problem with basing a decision of use or non-use of A-E inspection services on this last test. The problem is that GS and enlisted inspectors can not be hired and fired at will with the ebb and flow of inspection needs.

A final set of t-tests comparing the annual cost of the A-E inspector (or total A-E inspection cost for a project) with the annual cost for an in-house inspector indicates no significant difference between the two. A-E versus group 1 gives a T-value of -0.79, d.f. = 18.28, p-value = 0.221. A-E versus group 2 gives a T-value of -0.25, d.f. = 18.45, p value = .403.

It is apparent that a critical point exists somewhere between the daily cost and annual cost analysis. That is,

there must be some number of days at which an A-E inspector is more cost effective than an in-house inspector (or conversely, when a full-time in-house inspector is more cost effective than an A-E inspector).

An important assumption needs to brought out at this point. For the annual rate comparison, it was assumed that the in-house inspector only worked on one project and no others. But this would not be the case. The mean time the respondents said it would take an inspector each day to inspect as well as an A-E (using unconstrained hours) is 5.68 hours. The remaining time of that inspector's day could be used for other inspection duties. Therefore, in calculating a critical number of days when it becomes more cost effective to use in-house rather than A-E inspectors, the in-house costs were adjusted by a factor of 5.68/8.

Using the group 1 annual mean and standard deviation of $36608.76 and 5833.817 respectively, and a level of significance of 0.05(n=30, adjust by 5.68/8), the critical value was determined to be $26691.74. At an A-E hourly rate of $44.07, this equals 605.7 hours of inspection. Performing the same analysis using group 2 costs yields a critical value of $32,153.37 or 729.6 hours of inspection.

This means that, for group 1 data, if the A E is going to inspect for more than 605.7 hours in one year, it would be more cost effective for the Air Force to hire an

in-house inspector for a whole year. Similarly , for group 2 data, the Air Force would spend it's money more wisely hiring an in-house inspector if more that 729.6 hours of inspection would be required.

Many people may say at this point that they do not want to use an A-E who is paid $44.07 per hour, and they do not want the "average" in-house inspector. To make the decisions easier and more flexible, the table in Appendix A was compiled. It provides the critical number of hours that determines the most cost effective method of inspection for several different A-E hourly wages and several GS wage levels, given the number of hours per day the in-house inspector would work on the project. For example, if the A-E's price was $40.00 per hour, and you felt you needed a GS-9 inspector to inspect 6 hours per day to do the same work, the table gives a critical value of 707 hours. If the estimated hours for the A-E is greater that 707, you should hire an in-house inspector. If the estimated hours are less that 707 (for an entire year!), then hire the A-E.

IV. Conclusions and Recommendations

This chapter presents several conclusions drawn from the research, a few recommendations for implementing the results, and recommendations for further study.

Conclusions

1. The use of A-E Title II services can be made more cost effective. The two main criteria are the number of anticipated inspection hours and the preciseness of the Statement of Work.

2. There is a relationship between inspection costs and construction costs. Equation (6) provides a "ballpark" inspection cost for a construction project cost, but it should be used with caution and only as a general guide. The cost of inspection varies from about 6% of the construction for small projects to around 1% for large projects ($10,000,000). Once an estimated inspection cost is derived, the ideas in conclusion #3 should be reviewed.

3. Based on costs, there are times when an A-E inspector should be used, and times when an in-house inspector should be used. In general, projects of short duration and/or high intensity should have A-E inspectors. In-house inspectors should be used for longer projects. The cutoff points between "long" and "short" projects are stated in terms of manhours of A-E inspection

time and are based on the hourly cost of the A-E, the grade of the in-house inspector, and the number of hours the in-house inspector would inspect the project in question. To be very clear, at some number of hours of A-E inspection, it becomes more cost effective to hire a GS employee for an ENTIRE YEAR.

From a more practical point of view, it may not be realistic to hire an in-house inspector for only one year. The base should do some long term planning to see if there will be more projects in the next few years that the inspector could inspect. If the base anticipates several years of construction requiring additional inspection, than it is highly recommended that this analysis be performed and the results followed.

4. There is a need and desire for either a guide or regulation to write the A-E inspection Statement of Work. Several of the more common problems encountered when using A-E inspection services revolved around a lack of control or a "loose" specification. Engineering should insist on strict time limits for paperwork. A sample Statement of Work is provided in Appendix B. This should help in writing a Statement of Work for a particular project. There should be formal, planned meetings to keep Engineering informed of progress on the project. Since the A-E inspector really does not work for Engineering, there may be tendancy for him not to communicate with

Engineering as well or often as he should. The base should also make an effort to inform the A-E of the requirements of the base and the Air Force at the very beginning. There are many rules, procedures, forms, etc., of which the A-E is simply not aware.

5. There is a wide range of opinion concerning the quality/performance of A-E inspectors. All of the opinion questions except question 31/29 indicate that some people "like" A-Es and some people do not. The responses to questions 23/19 and 24/20 indicate several different reasons for the poor ratings. One reason was a poor SOW or poor relationship between the Air Force and the A-E, having little to do necessarily with the A-E himself. Others responded that the A-E was not very good to begin with. Regardless of the reasons, the answers indicate that there are "good" and "bad" A-Es. The base must be aware of this and show prudence in selecting their A-E. It can not be assumed that an A-E inspector will do better work or be more qualified that the in-house inspectors!

Recommendations

1. Provide the sample Statement of Work to all bases as a guide for the preperation of A-E Title II contracts. The bases should understand that this SOW is not a definitive SOW, nor should it be used verbatum, but it will provide a very good foundation for their contracts.

2. Provide the table in Appendix A to all bases. It is very easy to use and will provide a quick solution to the question of which method is more cost effective for their particular project. All numbers in the table may be straight-line interpolated.

Recommendations for Further Study

1. Make a complete study to find a better model for manpower projections other than basing them on historical data. Possibilities include project size, project complexity, dollar value, etc. Include a cost analysis for the use of overhires and military inspectors, as well as the A-E and GS in-house inspectors studied in this thesis.

2. Compare the entire method of Construction Management in the Air Force with methods used in industry. Study contract contents and procurement procedures.

Appendix A

Critical Hour Values for A-E vs. In-house Inspectors

4 hours per day inspection

A-E Cost per Hour	GS-7	GS-8	GS-9	GS-10	GS-11	GS-12
30	507	576	620	703	748	908
32.5	469	534	575	652	694	841
35	437	498	535	607	646	784
37.5	409	466	501	568	605	734
40	385	438	471	534	569	690
42.5	363	413	444	504	536	651
45	344	391	421	477	508	616
47.5	326	371	399	453	482	584
50	310	353	380	431	459	556

6 hours per day inspection

A-E Cost per Hour	GS-7	GS-8	GS-9	GS-10	GS-11	GS-12
30	760	864	930	1055	1123	1361
32.5	704	801	862	977	1040	1262
35	656	746	803	911	969	1176
37.5	614	699	752	853	907	1100
40	577	657	707	801	853	1034
42.5	545	619	667	756	805	976
45	515	586	631	715	762	924
47.5	489	556	599	679	723	877
50	466	530	570	646	688	834

8 hours per day inspection

A-E Cost per Hour	GS-7	GS-8	GS-9	GS-10	GS-11	GS-12
30	1013	1152	1240	1406	1497	1815
32.5	939	1068	1149	1303	1387	1682
35	875	995	1071	1214	1293	1567
37.5	819	931	1003	1137	1210	1467
40	770	876	942	1068	1137	1379
42.5	726	826	889	1008	1073	1301
45	687	782	841	954	1015	1231
47.5	652	742	799	905	964	1169
50	621	706	760	862	917	1112

EXAMPLE:

Suppose you want to compare the cost of using a particular A-E inspector with the cost of hiring an in-house civilian inspector (for a whole year). The A-E you are considering charges $40.00 per hour. You decide that it would take a GS-9 about 6 hours per day to inspect the same project just as thoroughly as the A-E. By looking at the middle table (6 hours per day for the in-house inspector), for an A-E cost of $40.00 per hour (left side of the table), and a GS-9 inspector (across the top of the table), the critical number of inspection hours is 707. This means that if the A-E you anticipate hiring is going to inspect less than 707 hours, you ought to hire the A-E. But if he wil inspect for more than 707 hours, you should consider hiring the GS-9. It is important to remember that the 707 hours of inspection do not have to be all on one project. As long as you are comparing the work of one A-E inspector to one GS inspector.

All numbers in the tables may be straight-line interpolated.

Appendix B

Statement of Work - A Guide

A. SCOPE OF WORK: The Architect-Engineer shall perform all services required for surveillance and inspection during the progress of construction up to the completion and final acceptance of the project, or for such time period as specified in the contract documents, in accordance with the requirements of these specifications.

B. GENERAL: The contracting officer will have overall jurisdiction for surveillance, inspection and administration during the construction of the project. For each construction project the Base Civil Engineer (BCE) will appoint a Project Officer to act as a representative of the contracting officer. The Project Officer will serve as the government point of contact for the A-E on all matters relating to the inspection of the construction project.

C. A-E PERSONNEL - PROJECT REPRESENTATIVE: The Architect-Engineer shall designate and assign a project representative and an alternate representative whose duty and responsibility is to inspect the construction work in progress and to determine if the work is properly executed in conformance with the drawings and specifications. The

project representative shall visit the job site at least once each day [or some minimum number of hours], or more than once if the work being performed is of such nature that more frequent visits are required to adequately inspect the work. As needed, fully qualified personnel will be used for inspection of structural, electrical and mechanical system. the personnel shall be capable of reading contract drawings and specifications and shall have a minimum of three years experience as construction inspector on similar construction projects or other experience acceptable to the contracting officer. The contractor shall furnish the name of the project representative in writing to the contracting officer prior to the pre-performance conference.

D. SPECIFIC DUTIES: The A-E project representative shall perform the following services:

1. Review drawings and specifications for familiarization with the construction contract requirements.

2. Interpret and clarify the intent of the drawings and specification for the contraction officer as necessary.

3. Attend conferences pertaining to construction project as required and directed by the contracting officer. Attendance at the pre-performance conference is [desirable/mandatory].

4. Observe the construction schedule and conditions which may delay construction completion and make recommendations to the contracting officer concerning contract time extensions.

5. Maintain progress charts [weekly/bi-weekly/____], and submit progress reports to the contracting officer.

6. Maintain a daily inspection record utilizing AF Form 1477, Construction Inspection Record. This form(s) will be provided by the BCE. All information as required by Form 1477 shall be annotated. Each days entry shall be signed by the construction inspector. A photo-copy of the log book shall be given to the Chief of Contract Management [weekly, bi-weekly, _____].

7.Observe tests performed at the project site, as required by contract documents, maintain records and report on such test results and procedures. Written results of test shall be provided to the Project Officer within [___] days.

8. Monthly provide [___] 3 X 5 color photographs which accurately and completely reflect the progress of all key elements of the construction.

9.Maintain records and files of correspondence, site conference reports, shop drawings, addenda, modifications, and supplementary drawings issued subsequent to award of contract.

10. Review shop drawings and material submittals and make recommendations for approval or disapproval to the Contracting Officer. A-E shall act on these submittals and return them to [BCE/CO] within [___] days.

11. Consider and evaluate suggestions or recommendations made by the construction contractor and provide written comments to the contracting officer/chief engineer.

11. Review application for payment and make recommendation to the contracting officer for disposition.

12. Insure the contractor maintains up to date record drawings (as-builts).

13. In the event design discrepancies become apparent during construction, the A-E shall be responsible for the correction of the design of such discrepancies and shall furnish the contracting officer the necessary drawings, specifications, cost estimates, etc., to enable modification of the construction contract and effect adequate amendments.

Options: -for all changes, not just design deficiencies

-only if A-E performed Title I services

14. The A-E shall insure the contractor adheres to specific notifications in the construction contract. Among those are:

Cutting and Welding Permits

Street Closing Notification

Utility Outages

Others

15. Insure the contractor schedules instruction/ training on all equipment for using agency personnel, as required by the contract.

16. Operational test: Insure all operational tests for the proper operation of all installations (i.e., electrical, mechanical, HVAC, etc.) and equipment are performed and document all discrepancies. Notify and coordinate with the Contracting Officer and the Project Officer for the time of the tests at least 7 calendar days in advance.

17. Include other, more specific requirements, as needed for projects involving:

Asbestos

Testing requirements

Hazardous Materials

Secure Areas (NSA, Command Post, etc.)

others

18. Prefinal Inspection: The A-E shall notify the Project Officer 7 calendar days prior to a prefinal inspection. The A-E shall provide a report of the prefinal inspection to include date, time, persons in attendance, their

organization, and the deficiencies listed. The report shall be given to the Project Officer five working days after the inspection.

19. Final Inspection: The A-E shall notify the Project Officer 7 working days prior to the final inspection. The A-E shall provide a report of the final inspection to include date, time, persons in attendance, their organization, and the deficiencies listed. The report shall be given to the Project Officer five working days after the final inspection. If not all deficiencies are corrected by the final inspection, the A-E shall make a follow-up report five working days after correction of deficiencies and completion of the contract.

20. Make construction deficiency list, attend final inspection and make recommendation to the Contracting Officer for final acceptance. All reports, files, test data, logs, etc., still in possession of the A-E shall be turned over to the Contracting Officer.

D. LIMITATION OF AUTHORITY: The Architect-Engineer or his designated project representative shall not perform any of the following work without authorization from the Contracting Officer during the construction phase of the work:

1. Authorize deviation from the contract documents.

2. Enter into the area of responsibility of the construction contractor's superintendent.

3. Advise or issue directions relative to any aspects of construction means, methods, techniques, sequences of procedures or for safety precautions and programs in connection with the work.

4. Provide services outside of the delivery order. (for open end contract)

5. Issue a certificate of payment.

E. AS-BUILT DRAWINGS: [Note: This section must be carefully coordinated with each construction project.]

[If contractor <u>is not</u> required to make as-builts...] Upon completion and acceptance of construction, the Architect-Engineer shall revise the reproducible mylars of the design drawings to conform to the actual construction. As-built drawings on reproducible mylar shall be submitted to the Contracting Officer within [___ (30)] days after completion of construction services and before final payment will be made. Marked-up prints of construction drawings will be furnished to the A-E by the construction contractor for his use in preparing the As-built drawings. The A-E shall locate all underground utilities by dimensions and permanent reference points. Upon completion of the revision of the tracings, the A-E shall submit them to the Contracting Officer.

[If contractor <u>is</u> required to make as-builts...] Upon completion and acceptance of construction, the A-E shall review the contractor's as-builts to insure they accurately reflect the actual condition at the completion of the project. The A-E shall recommend [approval/ disapproval] of the as-builts within [____] days of receipt.

Appendix C

Inflation Factors and Calculation for Adjusting Costs for Inflation and Location

Year	Factor
Jan. 1987	100.0
Jul. 1986	100.6
Jul. 1985	98.5
Jul. 1984	97.7
Jul. 1983	95.6
Jul. 1982	90.8

(partial list from Means Construction Cost Guide (8:332))

Equation to adjust costs:

$$\text{Adjusted Cost} = \frac{\text{Cost}}{(\text{inflation factor})\ (\text{economic factor})}$$

Assumptions for Economic Adjustment Factor:

1. Even though the factors are based on construction material costs and labor costs, it was assumed that the factors would present a relatively accurate weight to the costs by geographic area.

2. The "Total Weighted Average" for each location was used.

3. For bases that are not located near a major city, the factor for the closest reasonable city was used.

(factors taken from Means Construction Cost Guide (8:333-341))

Appendix D

Enlisted and Civilian Composite Rates by Grade for fiscal year 1987

Grade	Basic Pay	Total Annual Composite Rate
E-9	28,285	54,141
E-8	23,490	45,795
E-7	19,825	39,556
E-6	16,671	33,859
E-5	13,647	28,493
E-4	11,456	24,414
E-3	9,494	20,534
E-2	8,790	18,683
E-1	7,304	15,747

(Taken from: Table 3-3, AFR 173-13 (CI) 15 May 1987)

General Schedule	Pay	Pay Plus Fringes
GS-7	24,727	32,059
GS-8	28,124	36,463
GS-9	30,270	39,245
GS-10	34,323	44,500
GS-11	36,533	47,365
GS-12	44,304	57,440
GS/GM-13	53,708	69,632

("pay" values taken from: Table 3-8, AFR 173-13 (CI) 15 May 1987)

The pay plus fringes is calculated by taking the pay rate times 29.65% (4:IV-10).

Appendix E

Calculations

VEHICLES:

The initial cost and maintenance cost for a small pickup truck were obtained from Ms. Mary Schisler (10).

Initial cost ..	$5814 for 8 yrs	=	$726.50/yr
Maintenance costs	approx.	=	$38.45/yr
	Total		$764.95/yr

To factor this into manhour considerations, divide by the number of hours per year (2087).

($764.95/yr) / (2087 hr per yr) = $.37/hr/vehicle

The data from Question 33 on the Engineer's survey indicated that there are 0.242 vehicles per inspector (which is the same as 4.14 inspectors per vehicle) and the average amount of reimbursement for use of inspectors own vehicles is about $12.00 per inspector per month. The cost for inspection vehicles was then calculated by adding the cost for government supplied and personally owned vehicles.

.242 veh/man X $.37/veh/hr
+ $12.00/man/mo X 1 mo/173.92 hrs = $.158/man/hr

This cost of $.158/hour was added to the hourly cost of an additional in-house inspector.

COST OF ENGINEERING TIME HELPING A-Es

Fourteen people from engineering responded to Question 32 on the Engineering survey as to how many hours per week they spent helping A-Es find their way around the base, explaining forms, etc. By using the answers and the level of the respondent, their time was expressed in dollars per hour.

Hrs/week	Grade	Adjusted Wage	$/hr
1	GM-13	69632.42	.834
4	GM-13	69632.42	3.336
0	GS-11	47365.04	0
0	GM-13	69632.42	0
0	GM-14	83502.38	0
2	GS-11	47365.04	1.135
0	GM-13	69632.42	0
1	GS-11	47365.04	.567
0	GS-12	57440.14	0
0	GM-14	83502.38	0
1	GM-13	69632.42	.834
1	GM-13	69632.42	.834
1	GM-13	69632.42	.834
1	GM-14	83502.38	1.000
			9.374

The average for these 14 is $.67/hour. This figure was added into the hourly cost of an A-E inspector.

COST OF CONTRACTING TIME ADMINISTERING A-Es

Fifteen responses to questions 21 and 22 were received from Contracting giving the number of administration hours for the number of A-E inspection hours.

Grade	Admin hours	A-E hours	Admin hrs / A-E hours	Adjusted Wage	$/hr
GS-9	40	1940	.021	39245.06	.395
GS-11	0	1940	0	47365.04	0
GS-9	40	2080	.019	39245.06	.357
GS-9	20	1040	.019	39245.06	.357
GS-9	35	356	.098	39245.06	1.843
GS-9	28	284	.099	39245.06	1.862
GS-11	0	1176	0		0
GS-11	0	240	0		0
GS-11	1	1128	.00087	47365.04	.018
GS-11	1	288	.0035	47365.04	.079
GS-11	15	100	.15	47365.04	3.404
GS-11	10	50	.20	47365.04	4.539
MSgt	20	2080	.0096	39566	.181
MSgt	20	1040	.019	39566	.357
GS-11	78	1420	.055	47365.04	1.248
					14.621

Using the wages of the respondents and the ratio of administration hours to A-E hours provided a cost per hour for administration time of $.976/hour. This figure was added into the hourly cost of an A-E inspector.

$/hr = adjusted wage X (admin hours per A-E hour)
/ 2087 hrs/year

Calculating Daily Cost of A-Es

const. period	inspect. cost	inspect. hours	hrs per day*	cost per day**
577	122760	3856	9.4	314.77
300	51284	3000	14.0	262.30
840	99269	2176	3.6	170.16
180	19104	192	1.5	151.72
138	29597	1620	16.4	326.62
150	8907	200	1.9	87.75
280	31433	640	3.2	162.42
120	7770	240	2.8	95.24
84	7660	240	4.0	134.26
270	39564	1416	7.3	215.98
365	131928	2080	8.0	520.61
270	13993	435	2.3	77.78
390	49700	984	3.5	182.55
150	16720	391	3.6	159.86
150	5099	118.5	1.1	49.14
150	1723	40.4	0.4	17.72
150	1723	40.4	0.4	17.72
120	27323	640	7.5	332.52
540	173958	3620	9.4	467.14

*
hours per day = inspect. hours / (const. period * 5 / 7)

**
cost per day = {(inspect. cost/inspect.hours) + .670

+ .976 } X hours per day

Appendix F

Construction Costs and Inspection Costs

Construction Cost	Inspection Cost	Percent
4,846	1,723	35.56
39,416	1,723	4.37
43,940	5,099	11.60
103,607	40,952	39.53
116,718	29,597	25.36
127,081	16,719	13.16
220,896	8,907	4.03
267,459	19,104	7.14
312,308	114,864	36.78
318,261	7,769	2.44
400,359	28,597	7.14
405,681	12,088	2.98
450,170	27,322	6.07
464,959	7,660	1.65
489,658	154,862	31.63
547,153	31,432	5.74
610,820	39,563	6.48
738,486	13,992	1.89
835,073	5,219	0.62
922,509	23,062	2.50
1,140,211	14,854	1.30
1,159,163	40,570	3.50
1,164,215	24,509	2.11
1,584,407	49,699	3.14
3,087,441	98,798	3.20
3,211,109	106,342	3.31
3,537,517	34,104	0.96
4,005,898	99,268	2.48
4,741,131	34,831	0.73
5,342,074	51,283	0.96
5,397,942	116,263	2.15
6,323,619	114,974	1.82
6,597,250	145,529	2.21
6,624,087	122,760	1.85
6,883,525	96,138	1.40
7,406,620	173,958	2.35
8,233,157	289,587	3.52
8,245,500	131,928	1.60
8,353,007	209,368	2.51
9,685,417	100,272	1.04
10,879,994	61,323	0.56

Appendix G

Cover Letters and Surveys

LS (Capt Andy Perry, AUTOVON 785-6569)

Research Instrument on Architect-Engineering Inspection Costs

Chief of Engineering, Environmental, and Planning Branch

1. The attached research instrument was prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB OH. The researcher will use the results of the research instrument as the primary data source for determining how cost effective the Air Force is in using Architect-Engineering (A-E) Supervision and Inspection (Title II) services. Since you are a key player in the use of A-E services, the facts you provide and your perceptions on the effectiveness of A-E services are extremely valuable.

2. Please take a few minutes to complete the research instrument. You do not need to give your name. Upon completion, seal the research instrument in the attached envelope, and return it to the researcher within one week after receipt.

3. Although your participation in this research instrument is voluntary, your valued input will be extremely important in the overall evaluation of the cost effectiveness of A-E Title II services. Your time, effort, and cooperation are greatly appreciated, and without your input, this research effort could not be completed. Thank you for your cooperation.

DOUGLAS C. OSGOOD
Thesis Advisor
Course Director, MGT 425

2 Atch
1. Research Instrument
2. Return Envelope

LS (Capt Andy Perry, AUTOVON 785-6569)

Research Instrument on Architect-Engineering Inspection Costs

Chief of Contract Management

1. The attached research instrument was prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB OH. The researcher will use the results of the research instrument as the primary data source for determining how cost effective the Air Force is in using Architect-Engineering (A-E) Supervision and Inspection (Title II) services. Since you are a key player in the use of A-E services, the facts you provide and your perceptions on the effectiveness of A-E services are extremely valuable.

2. Please take a few minutes to complete the research instrument. You do not need to give your name. Upon completion, seal the research instrument in the attached envelope, and return it to the researcher within one week after receipt.

3. Although your participation in this research instrument is voluntary, your valued input will be extremely important in the overall evaluation of the cost effectiveness of A-E Title II services. Your time, effort, and cooperation are greatly appreciated, and without your input, this research effort could not be completed. Thank you for your cooperation.

DOUGLAS C. OSGOOD
Thesis Advisor
Course Director, MGT 425

2 Atch
1. Research Instrument
2. Return Envelope

LS (Capt Andy Perry, AUTOVON 785-6569)

Research Instrument on Architect-Engineering Inspection Costs

Chief of Base Contracting Office

1. The attached research instruments were prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB OH. The researcher will use the results of the research instrument as the primary data source for determining how cost effective the Air Force is in using Architect-Engineering (A-E) Supervision and Inspection (Title II) services. Since your personnel are key players in the use of A-E services, the facts they provide and their perceptions on the effectiveness of A-E services are extremely valuable.

2. Please distribute the attached research instruments to the PCO and ACO or Contract Administrator for your A-E contracts. Please distribute the research instruments as soon as possible as it is of upmost importance they be returned within one week of receipt. Individual responses will be returned anonymously.

3. Although participation in this survey is voluntary, inputs from your personnel will be extremely valuable in the overall evaluation of the cost effectiveness of A-E Title II services. Your time, effort, and cooperation are greatly appreciated, and without the input from your personnel, this research effort could not be completed. Thank you for your cooperation.

DOUGLAS C. OSGOOD
Thesis Advisor
Course Director, MGT 425

2 Atch
1. Research Instruments (2 ea)
2. Return Envelopes

LS (Capt Andy Perry, AUTOVON 785-6569)

Research Instrument on Architect-Engineering Inspection Costs

PCO/ACO/Contract Administrator

1. The attached research instrument was prepared by a researcher at the Air Force Institute of Technology (AFIT), Wright-Patterson AFB OH. The researcher will use the results of the research instrument as the primary data source for determining how cost effective the Air Force is in using Architect-Engineering (A-E) Supervision and Inspection (Title II) services. Since you are a key player in the use of A-E services, the facts you provide and your perceptions on the effectiveness of A-E services are extremely valuable.

2. Please take a few minutes to complete the research instrument. You do not need to give your name. Upon completion, seal the research instrument in the attached envelope, and return it to the researcher within one week after receipt.

3. Although your participation in this research instrument is voluntary, your valued input will be extremely important in the overall evaluation of the cost effectiveness of A-E Title II services. Your time, effort, and cooperation are greatly appreciated, and without your input, this research effort could not be completed. Thank you for your cooperation.

DOUGLAS C. OSGOOD
Thesis Advisor
Course Director, MGT 425

2 Atch
1. Research Instrument
2. Return Envelope

Survey Control Number: 87-52A
Expiration Date: 31 August 87

RESEARCH INSTRUMENT ON
ARCHITECT-ENGINEER INSPECTION COSTS

The following research instrument has been developed to solicit facts and your opinions on using A-E Supervision and Inspection (Title II) contracts. Your inputs will be included in an AFIT thesis which will examine the cost effectiveness of using A-E Title II services.

Your participation in this research effort is voluntary and anonymous; however, your cooperation is appreciated and will directly impact this research effort.

Opinion Questions --- Circle the number of your response.

Fact Questions --- Please provide the facts as accurately as you can in the space provided or on supplemental sheets.

Short Answer Questions --- Please provide answers that indicate how you really feel. If you don't have answers for every question, please don't feel that you have to fill up all the space provided. I'm looking for REAL problems and REAL answers.

If your base does not have any A-E Title II contracts , please answer questions 1 through 5 and return the survey.

If you have any additional comments after completing the survey, please write them on the back of the last page of the survey.

Please return the completed research instrument in the attached envelope within one week after receipt.

SECTION I

1. What MAJCOM are you in?

2. What is your grade/rank?

3. What is your office symbol?

4. What is your position title?

5. Has your base used, or does it now have any A-E Supervision and Inspection (Title II) contracts? If no; provide the base's reason, or your best judgment why your base has not used A-E's for inspection.

YES NO

If your base has not used A-E Title II contracts for inspection, do not complete the remaining questions, but return the research instrument with the above answers.

SECTION II

6. What guidance did you have to help you write your A-E Title II contracts? Check the applicable choice and give specifics.

___ Regulations?
___ Standardized format (i.e., AIA, etc)?
___ Copies from other bases?
___ Past contracts of your own?
___ Did the best you could?
___ Other? Please list

7. The AF should have a REGULATION on writing A-E Title II contracts.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

8. The AF should have a standardized format as a GUIDE to write A-E Title II contracts.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

9. What type of compensation arrangement are you using?

1. Negotiated firm-fixed-price lump sum
2. Firm-fixed-price based on percent of construction cost
3. Labor Hour
4. Cost Reimbursement
5. Other, please list

10. What do you feel would be the BEST compensation arrangement for A-E Title II contracts?

1. Negotiated firm-fixed-price lump sum
2. Firm-fixed-price based on percent of construction cost
3. Labor Hour
4. Cost Reimbursement
5. Other, please list

11. Are you using indefinite-delivery - indefinite-quantity (IDIQ) (open-end) A-E Title II contracts?

YES NO

12. The A-E's you have used are more qualified than in-house inspectors.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

13. Please provide the following information on your most recent A-E Title II contracts: the fiscal year of the contract, contract price of the CONSTRUCTION PROJECT, the contract period of the CONSTRUCTION PROJECT (in days), number of inspection manhours for the contracts, cost of inspection services.

	FY of Project	Cost of Project	Length of Project	Manhours of Inspection	Cost of Inspection
a.					
b.					
c.					
d.					
e.					

14. For the above projects, what grade level of inspectors would have been assigned based on the manning level of CM ?

a. _____ b. _____ c. _____ d. _____ e. _____

15. For the above projects, what grade level of inspectors should have been assigned to perform adequate inspection?

a. _____ b. _____ c. _____ d. _____ e. _____

16. How many hours per day would these inspectors realistically work on these particular projects?

a. _____ b. _____ c. _____ d. _____ e. _____

17. If this would not be enough hours to inspect the project as thoroughly as an A-E, how many hours per day would it take?

a. _____ b. _____ c. _____ d. _____ e. _____

18. Do your A-E Title II contracts include hours for supervision services (for things like submittal review, as-built drawing preparation, testing, modifications) or traveling time to and from the job site?

YES NO

19. If yes, how many hours per project at what cost? (Even if your contract was negotiated as a lump sum, please list the services you included)

Type of Service	Unit of Measure	Number of Units	Unit Cost
a.			
b.			
c.			
d.			
e.			

20. When there are A-E inspection services, it is better to have A-E supervision services as well.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

21. List up to 3 requirements in the A-E Title II contracts that have proven to be valuable.

1.

2.

3.

22. List up to 3 benefits you have received from using A-E Title II contracts.

1.

2.

3.

23. List up to 3 problems or difficulties that resulted from using A-E Title II contracts.

1.

2.

3.

24. List up to 3 items you didn't include in your contracts and either wish you had or wish you were able to include.

1.

2.

3.

25. Have you had times when the A-E inspector did not work due to funding problems with the A-E contracts? (i.e., change order, end of fiscal year, etc.)

YES NO

26. If yes, list up to 3 examples and state the impact.

1.

2.

3.

27. What can be done to change this?

28. A-E inspectors do a better job of inspecting than in-house inspectors.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

29. If a project is going to an A-E, the same A-E should do everything. This would include pre-design, design, supervision, and construction inspection.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

30. The same A-E firm used for design and construction inspection will tend to overlook design errors during the construction phase.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

31. A-E's should be given a bonus for providing good inspection services.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

32. How many hours per week do you spend helping A-E inspectors over and above the time you normally spend with the in-house inspectors (i.e., explaining forms, giving directions around the base, etc.)?

33. How many inspectors per vehicle do you have? (Please list the number of inspectors and the number of vehicles)

Number of inspectors _____ Number of vehicles _____

34. If inspectors are being reimbursed for using their own vehicles, estimate the total amount paid monthly to the inspectors.

If available, please send several examples of your A-E contracts when you return this survey.

Survey Control Number:87-52B
Expiration Date: 31 August 87

RESEARCH INSTRUMENT ON
ARCHITECT-ENGINEER INSPECTION COSTS

The following research instrument has been developed to solicit facts and your opinions on using A-E Supervision and Inspection (Title II) contracts. Your inputs will be included in an AFIT thesis which will examine the cost effectiveness of using A-E Title II services.

Your participation in this research effort is voluntary and anonymous; however, your cooperation is appreciated and will directly impact this research effort.

Opinion Questions --- Circle the number of your response.

Fact Questions --- Please provide the facts as accurately as you can in the space provided or on supplemental sheets.

Short Answer Questions --- Please provide answers that indicate how you really feel. If you don't have answers for every question, please don't feel that you have to fill up all the space provided. I'm looking for REAL problems and REAL answers.

If your base does not have any A-E Title II contracts , please answer questions 1 through 5 and return the survey.

If you have any additional comments after completing the survey, please write them on the back of the last page of the survey.

Please return the completed research instrument in the attached envelope within one week after receipt.

SECTION I

1. What MAJCOM are you in?

2. What is your grade/rank?

3. What is your office symbol?

4. What is your position title?

5. Has your base used, or does it now have any A-E Supervision and Inspection (Title II) contracts? If no; provide the base's reason, or your best judgment why your base has not used A-E's for inspection.

YES NO

If your base has not used A-E Title II contracts for inspection, do not complete the remaining questions, but return the research instrument with the above answers.

SECTION II

6. What guidance did you have to help you write your A-E Title II contracts? Check the applicable choice and give specifics.

___ Regulations?
___ Standardized format (i.e., AIA, etc)?
___ Copies from other bases?
___ Past contracts of your own?
___ Did the best you could?
___ Other? Please list

7. The AF should have a REGULATION on writing A-E Title II contracts.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

8. The AF should have a standardized format as a GUIDE to write A-E Title II contracts.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

9. What type of compensation arrangement are you using?

1. Negotiated firm-fixed-price lump sum
2. Firm-fixed-price based on percent of construction cost
3. Labor Hour
4. Cost Reimbursement
5. Other, please list

10. What do you feel would be the BEST compensation arrangement for A-E Title II contracts?

1. Negotiated firm-fixed-price lump sum
2. Firm-fixed-price based on percent of construction cost
3. Labor Hour
4. Cost Reimbursement
5. Other, please list

11. Are you using indefinite-delivery - indefinite-quantity (IDIQ) (open-end) A-E Title II contracts?

YES NO

12. The A-E's you have used are more qualified than in-house inspectors.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

13. Please provide the following information on your most recent A-E Title II contracts: the fiscal year of the contract, contract price of the CONSTRUCTION PROJECT, the contract period of the CONSTRUCTION PROJECT (in days), number of inspection manhours for the contracts, cost of inspection services.

	FY of Project	Cost of Project	Length of Project	Manhours of Inspection	Cost of Inspection
a.					
b.					
c.					
d.					
e.					

14. Do your A-E inspection contracts include hours for supervision services (for things like submittal review, as-built drawing preparation, testing, modifications) or traveling time to and from the job site?

YES NO

15. If yes, how many hours per project at what cost? (Even if your contract was negotiated as a lump sum, please list the services you included)

	Type of Service	Unit of Measure	Number of Units	Unit Cost
a.				
b.				
c.				
d.				
e.				

16. When there are A-E inspection services, it is better to have A-E supervision services as well.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

17. List up to 3 requirements in the A-E Title II contracts that have proven to be valuable.

1.

2.

3.

18. List up to 3 benefits you have received from using A-E Title II contracts.

1.

2.

3.

19. List up to 3 problems or difficulties that resulted from using A-E Title II contracts.

1.

2.

3.

20. List up to 3 items you didn't include in your contracts and either wish you had or wish you were able to include.

1.

2.

3.

21. How many manhours per quarter did you spend administering A-E Title II contracts during a) fiscal year 1986, and b) the first half of fiscal year 1987?

a. _____ b. _____

22. How many TOTAL A-E manhours of inspection were used during a) fiscal year 1986, and b) the first half of fiscal year 1987?

a. _____ b. _____

23. Have you had times when the A-E inspector did not work due to funding problems with the A-E contracts? (i.e., change order, end of fiscal year, etc.)

YES NO

24. If yes, list up to 3 examples and state the impact.

1.

2.

3.

25. What can be done to change this?

26. A-E inspectors do a better job of inspecting than in-house inspectors.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

27. If a project is going to an A-E, the same A-E should do everything. This would include pre-design, design, supervision, and construction inspection.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

28. The same A-E firm used for design and construction inspection will tend to overlook design errors during the construction phase.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

29. A-E's should be given a bonus for providing good inspection services.

1	2	3	4	5
Strongly Agree	Agree	Neutral	Disagree	Strongly Disagree

If available, please send several examples of your A-E contracts when you return this survey.

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AD-A187 023 COST EFFECTIVENESS OF ARCHITECT-ENGINEER TITLE II SERVICES(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF SYSTEMS AND LOGISTICS J A PERRY SEP 87 2/2

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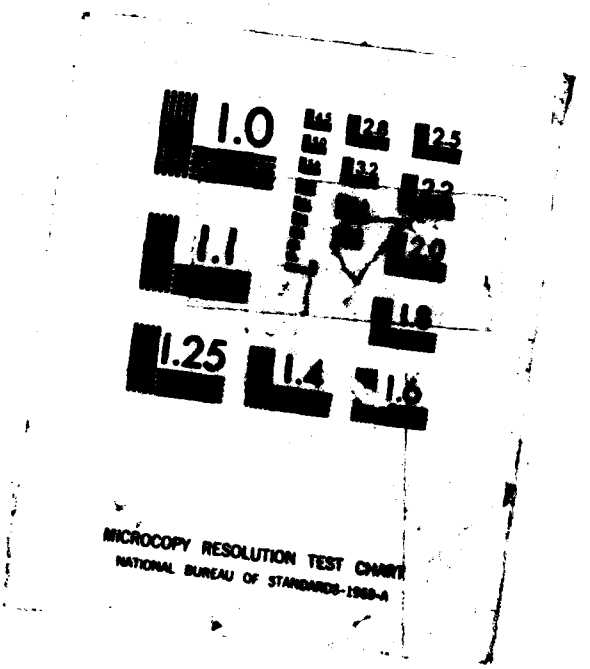
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VITA

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Assistant Professor of Contract Management

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Abstract

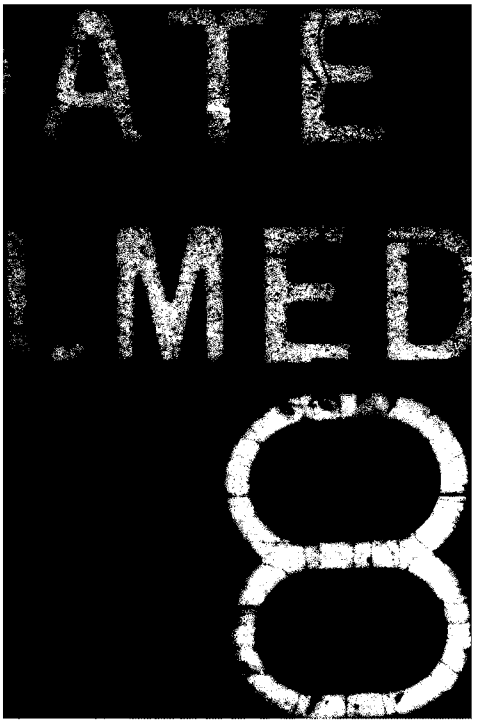
The purpose of this study was to determine the cost effectiveness of Architect-Engineering (A-E) Title II (inspection) services. There are two related questions which directed this study: What is the most cost effective method for using Title II services? How does this compare to increasing the number of government inspectors?

The study found several items to improve the effective use of A-E Title II services.

First, a well written Statement of Work will help eliminate the problems caused by coordination and communication difficulties. A Statement of Work to be used as a guide is included in Appendix E of this thesis.

Next, a linear regression model was developed to give a general idea of the appropriate ratio of inspection cost to construction cost.

Finally, a table was created to give the point at which it would be more cost effective to use an in-house inspector rather than an A-E inspector.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